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STUDENT REPORT

A GUIDE TO USAF HELICOPTER INSTRUMENT FLIGHT PROCEDURES

MAJOR LOREN O. STENDAHL 85-2610

"insights into tomorrow"

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Present information concerning USAF helicopter instrument procedures ~~is somewhat~~ dated and incomplete. This guide consolidates existing and new guidance into an up-to-date, single-source document for use by USAF helicopter pilots. If approved by HQ USAF Instrument Flight Center (IFC), portions of this guide will be incorporated into AFM 51-37. The paper first discusses the need for consolidated guidance, unique helicopter characteristics requiring changes to instrument procedures and how airspace design has been adjusted to accomodate helicopter operations. It then outlines procedures for performing basic helicopter instrument flight, and concludes with a chronological approach to helicopter instrument mission planning and accomplishment. Also included are proposed further changes to helicopter airspace design.

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PREFACE

The purpose of this guide is to consolidate existing information concerning helicopter instrument flight procedures into a single, up-to-date document for reference by USAF helicopter pilots. However, it should not be used as a substitute or a replacement for information or guidance contained in official Air Force flying publications. If approved by the USAF Instrument Flight Center (IFC), portions of this guide will be incorporated into AFM 51-37, Instrument Flying.

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To Major Bill Gibbons and Captain Bruce Gunn of the USAF IFC, who helped establish the need for research into this area and guided the direction of the final product.

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ABOUT THE AUTHOR

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TABLE OF CONTENTS

Preface -- iii
About the Author -- iv
List of Illustrations-------------------------------------- vi

CHAPTER ONE - THE NEED FOR CONSOLIDATED GUIDANCE ---------------- 1

CHAPTER TWO - HELICOPTER OPERATING CHARACTERISTICS
- Overview -- 5
- Operating Factors ------------------------------------- 5
- Conclusion -- 6

CHAPTER THREE - HELICOPTER INSTRUMENT APPROACH DESIGN CRITERIA
- Overview -- 7
- Criteria -- 7
- Terms --- 7
- Copter-Only Standard TERPS Criteria ------------------- 8
- Future Changes -- 10
- Conclusion -- 10

CHAPTER FOUR - HELICOPTER INSTRUMENT FLIGHT MANEUVERS
- Overview -- 11
- Control and Performance Concept of Instrument Flight ------- 11
- Basic Instrument Maneuvers ---------------------------- 12
- Conclusion -- 15

CHAPTER FIVE - HELICOPTER INSTRUMENT MISSION PROCEDURES
- Overview -- 17
- Preflight Planning ------------------------------------ 17
- Instrument Cockpit Check ------------------------------ 21
- Taxi Operations --------------------------------------- 23
- Takeoff and Inflight Procedures ----------------------- 24
- Holding Procedures ------------------------------------ 24
- Weather Requirements ---------------------------------- 24
- Approach Procedures ----------------------------------- 25
- Landing Phase --- 25
- Conclusion -- 26

CHAPTER SIX - CONCLUSION --------------------------------- 27

BIBLIOGRAPHY --- 29

INDEX -- 31

LIST OF ILLUSTRATIONS

FIGURES

FIGURE 5-1 - COPTER TACAN 213, MAYPORT NAF (KNRB), Mayport, Florida ---------------------------------- 19

FIGURE 5-2 - COPTER VOR/DME or TACAN 359, WHITING FIELD NAS (SOUTH) (NDZ), Milton, Florida ------------ 20

FIGURE 5-3 - COPTER VOR 061, TUPELO/C.D. LEMONS MUNI (TUP), Tupelo, Mississippi -------------------- 22

Chapter One

THE NEED FOR CONSOLIDATED GUIDANCE

As mentioned in the Preface, this guide will point out the differences in helicopter flight operations and how those differences have given rise to unique techniques and procedures essential for helicopter instrument flying. Why the need for such a guide? Aren't instrument procedures universal, regardless of the aircraft in question? Not necessarily. Perhaps we can get a feel for the problem by taking a look at an editorial on helicopters by television commentator Harry Reasoner:

> The thing is, helicopters are different from planes. An airplane by its nature wants to fly, and if not interfered with too strongly by unusual events or by a deliberately incompetent pilot, it will fly. A helicopter does not want to fly. It is maintained in the air by a variety of forces and controls working in opposition to each other, and if there is any disturbance in this delicate balance the helicopter stops flying, immediately and disasterously.
>
> There is no such thing as a gliding helicopter.
>
> This is why being a helicopter pilot is so different from being an airplane pilot, and why, in general, airplance pilots are open, clear-eyed, bouyant extroverts, and helicopter pilots are brooders, introspective anticipators of trouble. They know if something bad has not happened, it is about to. (1:32)

As in many humorous editorials, Mr. Reasoner's comments do contain certain grains of truth. While the personality differences between fixed wing and helicopter pilots will perhaps remain a subject for debate, the fact remains that helicopters are <u>different</u> from fixed wing aircraft. The design and construction of helicopter aircraft afford pilots unique operating capabilities, such as vertical takeoffs and landings, ability to hover, and exceptional maneuverability, to name a few. However, to get such capability requires certain trade-offs, particularly concerning flying procedures. First of all, different physical control applications are necessary to make the aircraft fly. Secondly, a helicopter's slow speed capability is also a limitation--a helicopter's normal flying speed is much slower than its fixed wing counterpart.

These distinctive factors of helicopter flight are particularly important when it comes to instrument flying. For example, under the control and performance concept of instrument flying, a fixed wing pilot alters the pitch of his aircraft to change its altitude, and adjusts his aircraft's power to change or maintain its airspeed. But helicopter design calls for just the opposite.

Additionally, a helicopter's slow speed capabilities and limitations have resulted in changes in airspace design and procedures. On the one hand, helicopters can operate under more severe weather conditions and within less airspace. But because of their limited speed, helicopters often must avoid the flow of other types of aircraft. (18:38)

The changes in flying procedures and airspace design, developed as a result of the helicopter's capabilities, have been around for some time. However, the information has often been presented in piecemeal fashion to USAF helicopter pilots, particularly since the closure of the USAF Instrument Flight Center (IFC) and Instrument Pilot Instructor School (IPIS) in December of 1977. (19:iv) Although HQ Air Force, through Air Training Command (ATC), assume the responsibility of maintaining AFM 51-37, ATC was, and still is, primarily involved with fixed wing training, and as such, relies on the U. S. Army to train it's undergraduate helicopter pilots. (2:1) The result has been limited helicopter instrument expertise at the headquarters level, and a reliance on small training or operational units to provide current and accurate information. While such units have done an admirable job, they have had to rely heavily on telephone calls and their own research to update information on instrument matters.

What has added difficulty to this data-gathering process is differences, redundancy and some lack in information concerning helicopter procedures. In the Army training program, for example, Air Force pilots are taught an entirely different set of weather minimums under which to operate in instrument conditions (14:4-1), than they will actually use during their Air Force assignments. (6:8-1 - 8-3; 8:6-3, 6-7) Yet, once under Air Force guidance, information is sometimes unnecessarily repeated. In the case of weather minimums for instance, identical reductions in ceiling and visibility requirements for helicopter takeoffs and landings is presented on four different occasions in two separate publications. (6:8-1, 8-3: 9:6-3, 6-7) Furthermore, although most important data is available, aircrews must research a variety of different sources to find it. For example, helicopter taxi operations have been modified to accomodate and/or minimize the effects of rotor system downwash when operating around airports. (15:C4-S3-8) Yet, no official Air Force publication addresses these procedures. In addition, although AFM 51-37 briefly discusses 'copter-only instrument approaches, there is no mention of the point in space procedure, the most "helicopter-unique" approach. Pilots must look to other publications, such as the Airman's Information Manual (AIM) or Air Force Manual (AFM) 55-9 (TERPS) to obtain such data.

This guide, then, will be a consolidation of existing and new guidance concerning helicopter instrument flight, for use by Air Force helicopter pilots. It will first discuss unique helicopter characteristics which result in the need for specific helicopter techniques and procedures. Then, it will address how the helicopter's performance capabilities have resulted in changes in airspace design, particularly in instrument approach criteria. Next, the discussion will concentrate on how to perform basic helicopter flight maneuvers. The concluding section will incorporate previous discussions into a chronological approach to helicopter instrument mission planning and flight.

Two final notes. This guide will be limited to only those procedures which are unique to helicopter instrument flight. It will not attempt to examine areas which pertain to both fixed wing and helicopter aircraft unless there is a significant difference in procedures. Additionally, it is not designed to be a replacement for any of the official publications listed herein, but should be used in conjuction with other references.

Chapter Two

HELICOPTER OPERATING CHARACTERISTICS

OVERVIEW

As mentioned in the Preface, helicopters possess some unique operating characteristics which affect the performance of instrument flight. Individuals undergoing either Undergraduate Pilot Training-Helicopter (UPT-H) or Rotary Wing Qualification Course with the U.S. Army will be exposed to helicopter aerodynamics and basic flight characteristics. (2:2) Therefore, all the subtle elements of basic helicopter flight procedures will not be discussed. However, there are three general factors which most affect the way we modify normal aircraft instrument procedures: required flight control applications to operate the helicopter, the effects of rotor system downwash, and the aircraft's limited forward speed. Each factor will be discussed individually to establish the need to modify the standard Air Force control and performance concept of instrument flying.

OPERATING FACTORS

Flight Control Applications.

The procedural steps of the fixed wing "control and performance" concept of instrument flying apply basically to helicopter instrument maneuvers. However, helicopter design requires some important modifications to this concept. In fixed wing flight, altitude adjustments are controlled by altering the aircraft's pitch attitude, and airspeed adjustments by changes in power. In helicopter operations however, the reverse is true: Power controls altitude and pitch controls airspeed. (4:2-12) Therefore, to change altitude in a helicopter, at a given airspeed, the pilot maintains a constant pitch attitude while adjusting power to climb or descend. An airspeed change requires an increase or decrease in pitch accompanied by a corresponding decrease or increase in power. Detailed procedural steps will be addressed in Chapter Four.

Effects of Rotor System Downwash.

The downwash created by a helicopter's rotors have two basic effects on flight procedures. Rotor wash causes erroneous indications on aircraft pitot-static instruments during ground operations and takeoffs, and can cause serious visibility problems.

Instrumentation. An aircraft altimeter is dependent upon undistrubed static air for valid readings. Unfortunately, a helicopter's rotor, while turning, disrupts this air, causing the altimeter to indicate lower than it should. This overpressure condition varies with different types of helicopters, but can be significant enough to exceed the 75 foot maximum error established by AFM 51-37. (4:1-6) Additionally, this disturbed airflow often invalidates altitude readings. (12:4-16) During a helicopter instrument takeoff, adding power further disrupts static flow, causing readings which indicate a descent and loss of altitude. (3:1-2) This is particularly critical during reduced visibility takeoffs described below. With these two factors in mind therefore, helicopter altimeter setting procedures need to be modified.

Visibility. Rotor downwash can also cause severe visibility problems close to the ground. Depending on the type of helicopter, rotor wash may reach velocities as high as 100 knots. (13:3-6) In areas of loose dirt or snow, this downwash can result in total loss of outside references once power is applied for takeoff or during landing. Coupled with erroneous pitot-static indications described above, the effects of rotor wash close to the ground compound an already critical phase of flight. Instrument takeoff procedures then, need tailoring.

Limited Forward Airspeed.

As mentioned in the Preface, a helicopter's comparatively slow speed and high maneuverability offer some distinct advantages. The primary effects these factors have on instrument maneuvers and procedures center around aircraft turning performance as it affects instrument flight. AFM 51-37 shows us that turning performance depends upon true airspeed. (3:10-5) In this sense, helicopter's have a distinct advantage in that their slow true airspeed requires much smaller bank angles for turns, and subsequently much less airspace in which to perform them. Virtually all helicopters maneuver in instrument conditions at approximately 90 to 120 knots. (18:20) If we examine Figure 8-4 in AFM 51 37, we see that if we wish to perform standard rate turns, the basis for all instrument maneuvering, we should establish bank angles of approximately 15 to 20 degrees. Also note that the turning radius in a standard rate turn at these airspeeds is only about 3000 feet, or one-half nautical mile. The next chapter will discuss what effects these factors have had on airspace design.

CONCLUSION

Highlighted above are the most obvious helicopter characteristics which require a modification of standard instrument procedures to helicopter operations. Differing pilot control inputs require adjustments to the control and performance concept of instrument flying. Helicopter rotor effects create additional problems close to the ground. And finally, a helicopter's slow speed creates the need for a closer look at bank angles and turning performance necessary for precision instrument flight. The next chapter will examine how the helicopter's capability has resulted in changes to airspace and instrument approach design, aimed at taking advantage of helicopter characteristics.

Chapter Three

HELICOPTER INSTRUMENT APPROACH DESIGN CRITERIA

OVERVIEW

Instrument approach procedures are designed and developed to help pilots make safe and efficient approaches and landings in weather conditions of low ceilings and/or visibilities. The US Standard for Terminal Instrument Procedures (TERPS), AFM 55-9, contains standardized approach criteria that have been approved to meet the requirements of both civil and military aircraft. (18:3-1) In the early 1960s, it became evident that in some instances helicopters had requirements and performance characteristics that allowed them to have instrument approach procedure standards that differed from those that applied to fixed wing aircraft. (4:99) This chapter will highlight some of the design criteria specific to helicopter operations, tailoring the information to a pilot's "need to know." The primary purpose is to give a pilot background information to help safely plan and accomplish an instrument flight. To begin are some applicable definitions, followed by the major differences between "Helicopter-Only" and standard TERPS criteria.

Chapter 11 of AFM 55-9 contains the guidelines by which helicopter approach procedures are designed. The following paragraphs paraphrase the salient differences in general concepts and definitions that are important to understanding 'copter-only instrument approaches.

CRITERIA

The criteria for helicopter procedures are based upon the premise that helicopters have special maneuvering characteristics. In developing these procedures, the intent was to provide relief from those portions of other TERPS chapters which are more restrictive than the criteria developed for helicopter operations.

TERMS

The following terms are unique to helicopter approach design, and are necessary to aid helicopter pilots in reviewing procedures.

HAL.

Height above landing area elevation.

HAS.

Height above surface. The height of the Minimum Descent Altitude (MDA) above the highest terrain/surface within a 5200 feet radius of the Missed Approach Point (MAP) in "Point In Space" approach procedures.

Landing Area.

In helicopter operations, that portion of the heliport or airport runway used, or intended to be used, for the landing and takeoff of helicopters.

Point In Space Approach (PSA).

An instrument approach procedure to a point in space. This point is also identified as the MAP, which in all cases will be in excess of 2600 feet from the landing area. The intent here is to enable the pilot to navigate to this point and (1) either proceed via visual flight rules (VFR) to the landing area, or (2) commence a missed approach. (5:100) This concept allows the pilot to perform an approach to a location rather than a designated runway or landing area.

COPTER-ONLY US STANDARD TERPS CRITERIA

This next segment will point out the major differences between 'copter-only criteria and standard TERPS criteria. It's interesting to note the correlation between the significantly reduced maneuvering airspace and increased descent gradients allowed in these procedures. Considering the airspeed and resultant increased turning performance outlined in Chapter One, these procedures appear to take full advantage helicopter performance.

Basic Criteria.

Helicopter-only procedures are designed to meet low altitude, straight-in procedures only. No circling approaches are permitted, nor are any high altitude criteria applicable. The procedures apply to helicopters using Category A approach minima and flying a maximum of 90 knots on final approach.

Descent Gradients.

Typical descent gradients during approaches for fixed wing aircraft are 250 to 500 feet per mile. Optimum gradients for helicopter approaches are 400 to 600 feet per mile, and in special circumstances may be increased to 800 feet per mile.

Length of Approach.

The optimum length of the intermediate approach segment is reduced to 2 nautical miles vice 10 for fixed wing aircraft. The maximum length is 5 nautical miles. Although a pilot cannot identify this segment in the aircraft, it's important to keep it in mind, since it will reduce the overall time in which to accomplish the approach.

Final Approach Criteria.

There are a number of changes in final approach criteria. Each type of approach is addressed separately:

Instrument Landing System (ILS). The optimum length of the final approach course is reduced from 8.2 to 3 nautical miles. The minimum length is 2 nautical miles, and a length exceeding 4 nautical miles should only be used if an operational requirement exists.

VOR AND NDB With No Final Approach Fix (FAF). The length of the final approach segment, after completing the procedure turn, is 5 nautical miles, vice 10 nautical miles for other aircraft.

VOR/DME, TACAN, VOR, or NDB With A FAF. The minimum length of the final approach segment varies slightly, depending upon whether or not the pilot must turn to a new heading after passing the FAF. For turns of 30 degrees or less, the length is 1 nautical mile; for 60 degree turns, 2 nautical miles; and for 90 degree turns, 3 nautical miles. For standard procedures, minimum final approach course length is at least 5 nautical miles.

Missed Approach.

Here there are two important changes. First, the length of the segment is cut in half, from 15 to 7.5 miles. Secondly, and perhaps most significant, is that the slope of the climb is increased. The standard ratio of distance flown to altitude gained is increased from 40:1 to 20:1 (primary area) and from 12:1 to 4:1 (secondary area).

Visibilities.

The last major area of concern is visibility. The helicopter's slow speed and maneuverability result in a significant reduction in visibility criteria in designing approaches.

Point In Space Approaches. Visibility should be a minimum of 3/4 mile if the height above the surface (HAS) does not exceed 800 feet. Otherwise, one mile.

Non-precision Approaches. The visibility can be reduced to 1/2 mile for HAL areas of 250 to 600 feet, 3/4 miles for a HAL of 601 to 800 feet, and one mile for a HAL of greater than 800 feet.

Precision Approaches. Visibility criteria here is largely dependent upon available area lighting. Without approved lighting, visibility must be at or above 1/2 mile, or 2400 feet runway visual range (RVR). With approved lighting systems in place, this visibility requirement may be reduced to 1/4 mile.

FUTURE CHANGES

Helicopter pilots may soon see some changes to current instrument approach design criteria. Recently, the Federal Aviation Administration (FAA) held a National Airspace Review which included a Helicopter Operations Task Group to discuss helicopter instrument approach procedures. (16:1) After reviewing present and proposed procedures, the task group recommended the following:

Decelerative and Low Speed Approaches.

Currently, helicopter instrument approach design is based upon a fixed final approach speed of 90 knots. (4:100) There are no instrument approach procedures which exploit the helicopter's ability to maneuver at 40 knots or lower as is done on visual approaches. The task group therefore, recommended that such decelerative approaches be designed to take advantage of this capability. This would include decelerating approaches down to a hover. (16:4) The group further recommended that the FAA include specified low airspeed approaches (e.g. fixed at 40 knots) to accommodate microwave landing system heliport approach profiles. (16:5)

Copter Straight-In Approaches.

Due to the flexibility and approach characteristics of the helicopter, certain circling-only fixed wing instrument approach procedures could be readily adapted to helicopter straight-in use. This would be done by adding a box of helicopter minima to accompany the circling minima identified for Category A, B, C and D aircraft. The group recommended that helicopter straight-in minima be added to all instrument approach procedures that have circling-only minima. (16:11)

Circling Approaches.

As mentioned, circling criteria are not applicable to 'copter-only approaches. However, the proposed revision to AFM 55-9 (TERPS) includes provisions for 'copter-only circling procedures.

While the above recommendations are not yet in effect, helicopter pilots should be aware that these changes may soon be incorporated into future guidance.

CONCLUSION

Helicopter instrument approach design criteria takes full advantage of the aircraft's capabilities. As stated in Chapter One, the slow instrument maneuvering speed and resultant performance allows airspace designers to set much less restrictive rules for establishing 'copter-only approaches. While 'copter-only approaches are not as common as standard instrument designs, helicopter pilots must be familar with the reduced restrictions inherent in their makeup. As will be pointed out in Chapter Five, careful planning of this type approach could preclude embarassment or even disaster.

Chapter Four

HELICOPTER INSTRUMENT FLIGHT MANEUVERS

OVERVIEW

The previous two chapters dealt with unique helicopter operating characteristics and how airspace design has been adjusted to take advantage of those characteristics. In this chapter, procedures and techniques for performing helicopter instrument maneuvers will be addressed. It will begin with a review of the control and performance concept of instrument flight, as applied to helicopter operations, as mentioned in Chapter Two. It will then proceed to a discussion of the helicopter instrument takeoff, basic inflight maneuvers, and conclude with unusual attitude recoveries.

CONTROL AND PERFORMANCE CONCEPT OF INSTRUMENT FLIGHT

In order to successfully perform the maneuvers described in this chapter, it is important to fully understand the control and performance concept of helicopter instrument flying. As mentioned in Chapter Two, the procedural steps of this concept apply to both fixed wing and helicopter aircraft. However, unlike in fixed wing operations, the helicopter power control (collective lever) controls altitude or rate of altitude change, and pitch (cyclic stick) controls airspeed. (3:2-12) To maintain or change altitude therefore, the pilot sets or adjusts power to a setting he or she knows will give the desired performance. In helicopter operations, power settings are most often described in terms of "pounds" or "percent" of torque, fuel flow, manifold pressure, etc. (3:3-4) Just as in flying fixed wing aircraft, it is important that a pilot become familiar with the approximate power settings needed for a specific performance. (3:2-6) This information obviously differs from aircraft to aircraft, and can most easily be found in either the aircrew flight manual or training guide. For example, in UH-1 operations, changing power by one pound of torque will produce a vertical velocity change of approximately 100 feet-per-minute (FPM). (8:9-2) Using this information then, to arrest a 200 FPM rate of decent, the pilot would merely increase power by two pounds of torque. If necessary to climb back to altitude, for example a climb of 400 feet, the pilot would simply apply the known power settings to the suggested technique in AFM 51-37 of adjusting power to produce a vertical velocity rate of twice the amount of altitude to be gained. (3:2-6) In this case, the pilot would increase power by eight pounds of torque.

As stated, helicopter pitch attitude is the primary airspeed control. Any change in pitch will have an immediate effect on airspeed, and to a lesser degree, on altitude. (3:2-6) Airspeed changes, then, are accomplished by changing the helicopter's pitch attitude while simultaneously adding/reducing power to maintain or change altitude. Conversely, pitch attitude remains constant during altitude changes, if desired to maintain a constant airspeed. Unfortunately, there is no present information on pitch settings required for given airspeeds. However, through experience and training, aircrews can easily determine appropriate pitch attitudes needed for their operations.

BASIC INSTRUMENT MANEUVERS

With a thorough understanding of the helicopter control and performance concept of instrument flight, the discussion will now proceed to selected helicopter maneuvers.

The Instrument Takeoff (ITO).

The helicopter ITO is a particularly challenging maneuver for several reasons. In the first place helicopters, because of their slow speed capability described in Chapter One, are often tasked to operate under more severe weather regulations. In fact, Army pilots with certain experience levels are authorized to takeoff without any ceiling or visibility minimums. (14:4-2) Even the Air Force permits helicopter takeoffs with only published visibility minimums if using a 'copter-only approach procedure to a departure alternate. (7:6-3) When operating under these conditions, the pilot can quickly enter instrument meteorological conditions (IMC) with no reference to the ground.

The effects of rotor system downwash can also severely reduce visibility. Induced downward airflow from a helicopter's rotors may reach velocities of 60 to 100 knots, depending on the size and weight of the aircraft. (13:3-6) Since helicopters often operate from unprepared or remote locations in the presence of loose dirt or snow, downwash can easily result in a significant loss of visual references, especially during hover operations. Aircrews are warned not to attempt to hover under any IMC weather as instrumentation is inadequate. (9:9;1)

Finally, rotor system downwash effects pitot-static instrumentation, as previously mentioned. Rotor wash disrupts static air around the aircraft and results in unrealiable altimeter, vertical velocity and airspeed indications. (3:1-9) In fact, in aircrew flight manuals, pilots are warned that airspeed indications should be considered unrealiable when forward speed is less than 25 to 40 knots, again depending on size and type of aircraft. (8:2-9, 9:9-2) Additionally, altimeters and vertical velocity indicators will actually indicate a loss of altitude as power is applied for takeoff. (3:1-2)

With these facts in mind, it can be seen that the helicopter ITO is a particularly critical phase of flight. However, the following procedures have been established to reduce the adverse effects of helicopter characteristics during an ITO. They can be divided into two categories: normal and reduced visibility takeoffs.

Normal ITO. As in all helicopter ITOs, pilots should adjust attitude indicators to the "zero trim dot" reading prior to takeoff. This procedure will ensure forward velocity is maintained as long as the aircraft's pitch is held in this position when airborne. (9:9-2) Once ready for takeoff, use normal visual procedures to establish a hover. Then, simultaneously set the predetermined takeoff power setting and lower the aircraft's pitch to begin forward flight. Upon reaching the climb airspeed recommended by the flight manual, readjust pitch to maintain it. Proceed with normal climb procedures. (8:9-2)

Reduced Visibility ITO. After completing pre-takeoff checks, smoothly increase power to the predetermined takeoff power setting in the flight manual. Maintain heading and attitude, by reference to the instruments, until noting a positive climb indication on the altimeter and vertical velocity indicator. Then set the pitch five degrees nose low until reaching recommended climb airspeed (9:9-2) (Note: Helicopters with wheel-type landing gear may also elect to make running takeoffs if operating from normal runways). Using this procedure will provide a much quicker transition to IMC.

AFM 51-37 contains sound and detailed techniques for accomplishing commonly used flight maneuvers for helicopters. While it is unnecessary to repeat this information, a brief review may prove helpful. Keep in mind that basic instrument flight techniques are essentially the same for both fixed wing and helicopter aircraft with the exception of differing control applications mentioned previously.

Straight and Level Flight.

Straight and level unaccelerated flight consists of maintaining desired altitude, heading and airspeed. (3:2-6) The basis of good altitude and airspeed control lies in knowing approximate power settings for your aircraft at various altitudes, airspeeds and configurations used throughout a normal mission. When deviations occur, smooth applications of pitch and/or power back to known settings will generally result in desired performance. The key difference in helicopter versus fixed wing operations is that altitude changes, at a constant airspeed, require only power changes--pitch remains set for the given airspeed. Airspeed adjustments, like in fixed wing flight, require both pitch and power applications. (3:2-6)

Turns.

Turns can be classified as either normal (standard rate or less) or steep, but in either case, the pitch, bank and power principles of straight and level flight still apply. Additionally, procedures for entering a turn, maintaining bank angles, altitude and airspeed are essentially identical to those used for fixed wing flight. However, it is important to note that the bank angles used in helicopters are significantly smaller, due to the slow cruising and maneuvering airspeeds used.

Helicopters normally operate under instrument conditions from between 90 and 120 knots. (18:3-7) If we examine Figure 8-4 in AFM 51-37, we can see that at these relatively slow airspeeds, 15 to 20 degrees of bank will result in a standard rate turn, which is the most commonly used rate during helicopter instrument flight. (3:2-7) While any turn greater than standard rate is considered a steep turn (12:4-24), most helicopters practice steep turns using 30 degrees of bank, which is the maximum angle of bank recommended under instrument conditions. (10:6-2)

Climbs and Descents.

Climbing and descending maneuvers are classified into two general types, constant airspeed and constant rate. (3:2-7) Here, helicopter characteristics offer pilots somewhat of an advantage over fixed wing procedures. Regardless of the type of climb or descent required, by definition, an airspeed selected will remain the same throughout the maneuver. As previously mentioned, this requires no change in pitch, so the attitude "picture" will remain fixed, requiring the pilot to make one less control input. Once again, with the exception of control applications, procedures used for performing instrument climbs and descent are essentially universal.

Unusual Attitude Recoveries.

Along with the ITO, helicopter unusual attitude recoveries present distinctively unique considerations. Due to rotary wing aerodynamics as well as the helicopter concept of control and performance, unusual attitude recoveries in helicopters are decidedly different from those in fixed wing aircraft. Application of improper recovery techniques can result in blade stall, power settling or an uncontrollable yaw if recovery is delayed. (3:2-16) The following techniques may be used if such procedures are not in the aircraft's flight manual:

Diving. If diving, consider altitude, acceleration limits, and the possibility of encountering blade stall. If altitude permits, avoid rolling pullouts. To recover from a diving unusual attitude, roll to a wings level indication, then establish a level flight attitude on the attitude indicator. Adjust power as necessary and resume a normal cross-check. (3:2-6)

Climbing. If climbing, consider pitch attitude and airspeed. If the inadvertent pitch attitude is not extreme (10 degrees or less from level flight), smoothly lower the aircraft back to a level flight indication, level the wings, and resume a normal cross-check, using power as required. For extreme pitch attitudes (above 10 degrees), bank the aircraft in the shorter direction toward the nearest 30 degree bank index. The amount of bank used should be commensurate with the pitch attitude and external conditions, but should not exceed 30 degrees of bank in making the recovery. Allow the aircraft symbol on the attitude indicator to fall toward the horizon, level the wings and adjust aircraft attitude back to a level flight indication. Use power as necessary throughout the recovery. (3:2-17) NOTE: In helicopters encountering an unusual attitude as a result of blade stall, reduce collective (power) before correcting attitude if the aircraft is in a climbing unusual attitude. This will aid in eliminating the possibility of aggravating the blade stall condition. To avoid blade stall in a diving unusual attitude recovery, reduce power and bankangle before initiating a pitch change. In all cases, avoid abnormal positive or negative G loading which could lead to additional unusual attitudes or aircraft structural damage. (3:2-17)

CONCLUSION

With few exceptions, helicopter instrument flight maneuvers can be performed using the same basic control and performance concept used in fixed wing aircraft. Pilots of either should be thoroughly familiar with power settings, airspeeds and turning performance to aid in successfully performing instrument maneuvers. Helicopter design requires slight modification of procedures to accomodate differences in control applications. In addition, helicopter characteristics necessitate significant changes to procedures for performing instrument takeoffs and unusual attitude recoveries, two particularly critical phases of flight.

The next chapter of this guide will address those factors specific to helicopter instrument flight which should be considered when planning and performing an instrument mission.

Chapter Five

HELICOPTER INSTRUMENT MISSION PROCEDURES

OVERVIEW

The previous two chapters addressed the unique characteristics of helicopter operations and how those characteristics resulted in changes to airspace design and instrument flight procedures and techniques. The purpose of this section is to apply that information, in conjunction with additional flight planning considerations, to an instrument mission profile. The discussion will proceed using a chronological approach, beginning with preflight planning, on through ground operations, departure, enroute and arrival procedures, and conclude with final landing factors.

PREFLIGHT PLANNING

A successful instrument mission begins with sound preflight planning and helicopter operations are no exception. Items to be checked during preflight of any instrument mission are fairly standard. However, as mentioned before, helicopter performance allows pilots to apply some different criteria to planned profiles. The following planning subareas contain certain helicopter-unique consideration.

Destination Requirements for Filing Purposes.

When filing an instrument flight plan, all requirements concerning availability of approach aids at the destination airfield apply equally to all types of aircraft. (6:8-1) Weather requirements are also the same, with one exception: Helicopter pilots planning to use a fixed-wing instrument approach procedure (IAP) may use one-half the published visibility for any suitable approach. However, in no case may the minimums be less than one-quarter mile. (6:8-1) If planning to use a 'copter-only IAP, weather minimums must be used as published. (6:8-1)

When to Designate an Alternate Aerodrome.

Basic restrictions apply. However, helicopters may use less restrictive weather minimums. Pilots must list an alternate whenever distination ceiling is below 700 feet or visibility is less than one mile. (6;8-2)

Alternate Aerodrome Weather Requirements.

The only difference in procedures occurs when using an alternate with a published approach procedure. In this case, ceiling at the alternate must be at least 700 feet, or 500 feet above the lowest published landing minimum, whichever is higher. (6:8-2) Visibility must be one mile, or one-half mile above the lowest compatible landing minimum, whichever is higher. (6:8-2) These values apply to both fixed wing and 'copter-only IAPs.

Takeoff Minimums.

Takeoff minimums are normally established by the using major command. (6:8-2) Generally, these minimums will differ depending upon type of mission and whether or not a departure alternate is used. (9:6-3). Carefully check requirements prior to departure.

Instrument Approach Procedure (IAP) Review.

AFM 51-37 recommends that, prior to departure, pilots become familiar with all aspects of the IAP they intend to use. (3:3-6) As outlined in Chapter Three, 'copter-only IAPs may contain some unique features which should be understood before reaching the initial approach fix. Before reviewing some 'copter-only approaches, consider the following:

> Helicopter only approaches are identified by the terms "COPTER", the type of facility producing final approach course guidance, and a numerical identification of the final approach course; for example, COPTER VOR/DME or TACAN 359 (Figure 5-2), or COPTER TACAN 243 (Figure 5-3). The criteria for COPTER approaches are based on the premise that the helicopters are aircraft with special maneuvering characteristics. This type of approach is based on an airspeed not exceeding 90 knots. COPTER approaches are generally shorter in length and the descent gradient on the approach can be steeper than on a fixed wing approach. (3:6-14.4)

To illustrate these concepts, we can use the following 'copter-only IAPs:

Length of Approach Course. Looking at Figure 5-1 (16:179), plan view, we can see an example of a fairly short procedure. The initial approach fix (IAF) is only one mile from the DME arc procedural track. From the IAF to the final approach fix (FAF) is thirteen miles, and final approach course approximately 1.8 mile. While this approach should not be difficult to accomplish, careful review could prevent pilots from becoming rushed during the maneuver.

Descent Gradient. Low altitude approaches are designed to require a maximum descent gradient of 500 feet per nautical mile. (3:3-6) In 'copter-only approaches however, the gradient may be as high as 800 feet per nautical mile. (3:3-6) In Figure 5-2 (16:340), we can see an example of a high descent rate, listed in the second NOTE on the plan view. This descent rate of 650 feet per mile, flying at 90 knots, equates to approximately a 1000 feet per minute rate descent. Notice also the required descent from the FAF to the missed approach

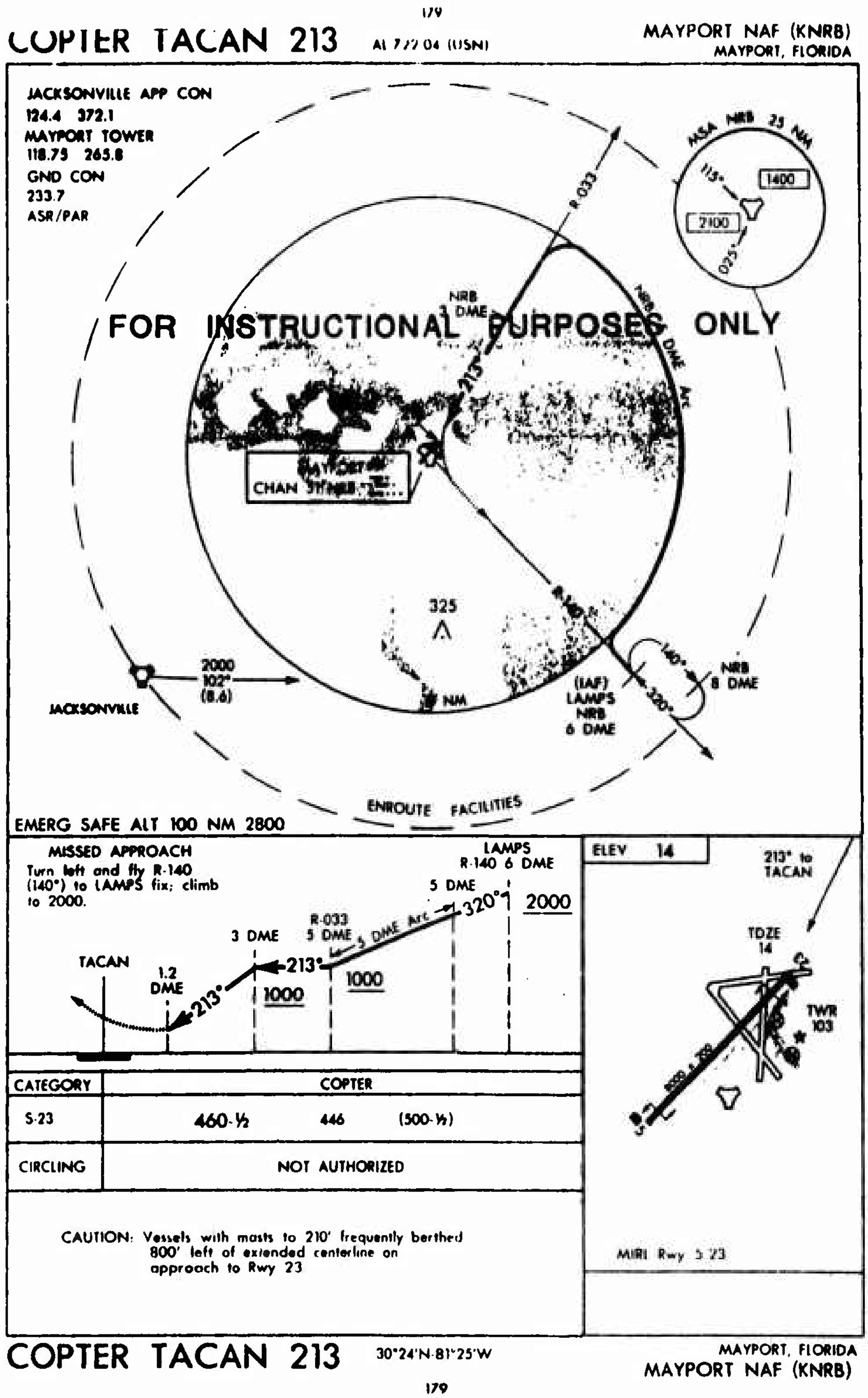
179
COPTER TACAN 213
MAYPORT NAF (KNRB)
MAYPORT, FLORIDA
JACKSONVILLE APP CON
124.4 372.1
MAYPORT TOWER
118.75 265.8
GND CON
233.7
ASR/PAR
MSA NRB 25 NM
115°
1400
2100
025°
R-033
NRB 3 DME
FOR INSTRUCTIONAL PURPOSES ONLY
NRB 6 DME Arc
213°
CHAN
R-140
325
2000
102°
(8.6)
JACKSONVILLE
NM
(IAF)
LAMPS
NRB
6 DME
140°
320°
NRB
8 DME
ENROUTE FACILITIES
EMERG SAFE ALT 100 NM 2800
MISSED APPROACH
Turn left and fly R-140 (140°) to LAMPS fix; climb to 2000.
LAMPS
R-140 6 DME
5 DME
320°
2000
R-033
5 DME
5 DME Arc
3 DME
213°
1000
1000
TACAN
1.2
DME
213°
CATEGORY
COPTER
S-23
460-½
446
(500-½)
CIRCLING
NOT AUTHORIZED
CAUTION: Vessels with masts to 210' frequently berthed 800' left of extended centerline on approach to Rwy 23
ELEV 14
213° to TACAN
TDZE
14
TWR
103
MIRL Rwy 5-23
COPTER TACAN 213
30°24'N-81°25'W
MAYPORT, FLORIDA
MAYPORT NAF (KNRB)
179

Figure 5-1

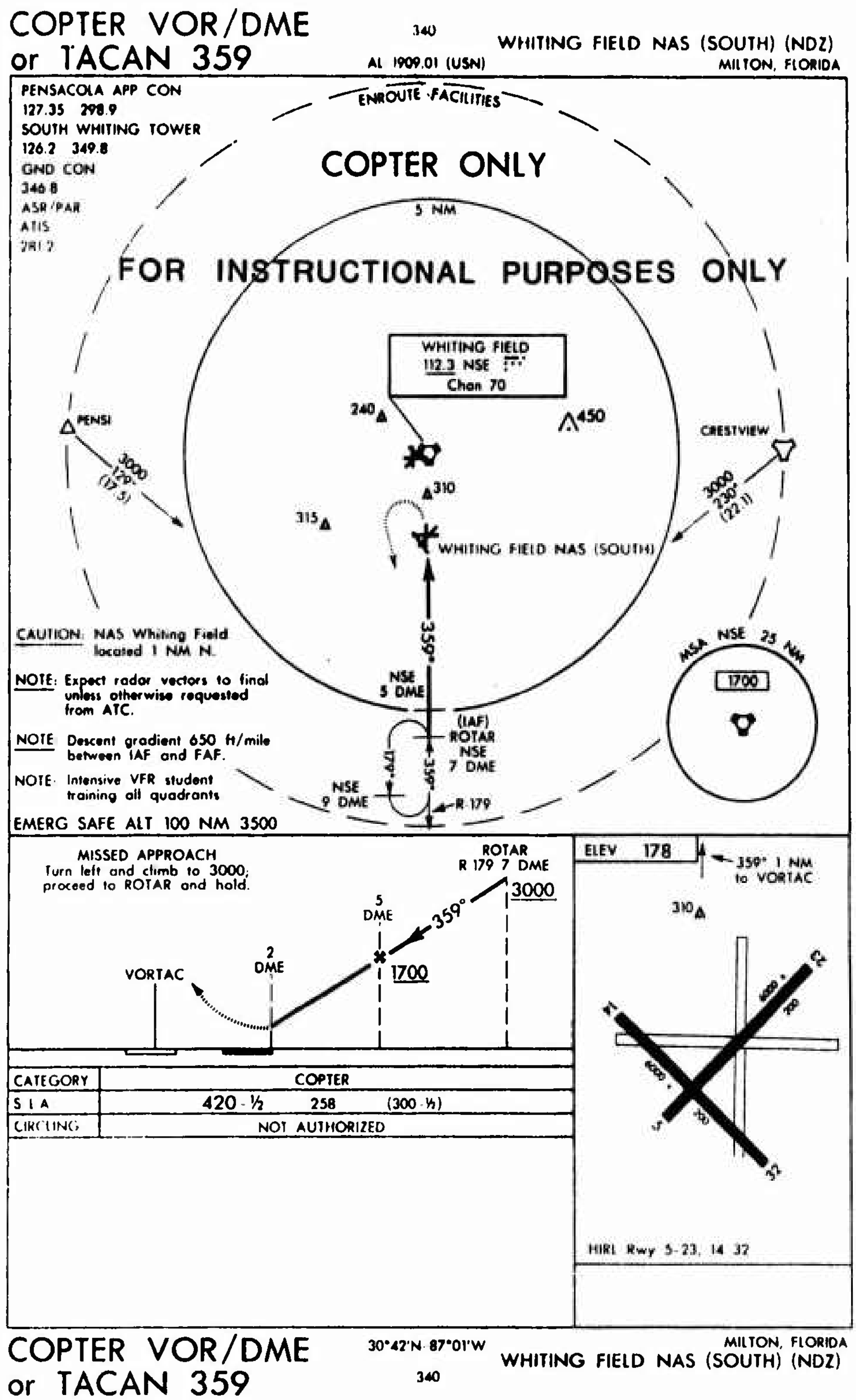
COPTER VOR/DME
or TACAN 359
340
AL 1909.01 (USN)
WHITING FIELD NAS (SOUTH) (NDZ)
MILTON, FLORIDA
PENSACOLA APP CON
127.35 298.9
SOUTH WHITING TOWER
126.2 349.8
GND CON
346 8
ASR/PAR
ATIS
281 2
ENROUTE FACILITIES
COPTER ONLY
5 NM
FOR INSTRUCTIONAL PURPOSES ONLY
WHITING FIELD
112.3 NSE
Chan 70
240
450
PENSI
3000
120°
(17.5)
CRESTVIEW
3000
230°
(22.1)
310
315
WHITING FIELD NAS (SOUTH)
359°
CAUTION: NAS Whiting Field located 1 NM N.
NOTE: Expect radar vectors to final unless otherwise requested from ATC.
NOTE: Descent gradient 650 ft/mile between IAF and FAF.
NOTE: Intensive VFR student training all quadrants
NSE 5 DME
(IAF) ROTAR NSE 7 DME
179°
359°
NSE 9 DME
R-179
MSA NSE 25 NM
1700
EMERG SAFE ALT 100 NM 3500
MISSED APPROACH
Turn left and climb to 3000; proceed to ROTAR and hold.
ROTAR
R 179 7 DME
3000
5 DME
359°
1700
2 DME
VORTAC
ELEV 178
359° 1 NM to VORTAC
310
HIRL Rwy 5-23, 14-32
CATEGORY | COPTER
S I A | 420-½ 258 (300-½)
CIRCLING | NOT AUTHORIZED
COPTER VOR/DME
or TACAN 359
30°42'N-87°01'W
340
MILTON, FLORIDA
WHITING FIELD NAS (SOUTH) (NDZ)

Figure 5-2

point, which computes to over a 600 feet per minute vertical velocity.

Point In Space Approach (PSA). While this type of approach is rare, it does illustrate how approach design takes advantage of helicopter capability. In Figure 5-3 (16:315), the IAP brings the helicopter to a point in space, from where the pilot is expected to proceed visually, via ground references, to the airport. If planning to use this type approach, pay careful ·ttention to weather conditions upon arrival, as visual meteorologinal conditions (VMC) are required to maneuver.

Missed Approach. Review the puclished missed approach procedure to ensure you can achieve the published climb gradient. For 'copter-only procedures, the missed approach is based on a climb gradient of at least 352 feet per mile, over twice the angle used in fixed wing IAPs. (5:6)

INSTRUMENT COCKPIT CHECK

The requirement for pilots to properly check their aircraft's instrumentation prior to takeoff on an instrument mission applies equally to both fixed wing and helicopter aircrews. Procedures for accomplishing an instrument cockpit check are clearly outlined in AFM 51-37 and the aircraft flight manual. However, there is one major difference in procedures applicable to helicopters.

Altimeter Setting Procedures.

As indicated previously, a helicopter's rotor system can effect pitot-static instruments in various ways. Essentially, the altitude indicated on the altimeter may be in error if the altimeter is checked with the rotor turning, due to a pressure differential caused by rotor downwash. (This pressure difference causes the altimeter to indicate lower than actual). (3:1-9) To counteract this effect, three separate procedures have been established to ensure valid altimeter readings. The procedure selecteu w ll depend upon the situation and sequence of checklist items for each aircraft model. (3:1-9)

Procedure One. Use this procedure if the check is completed prior to rotor engagement at a known elevation and with a current altimeter setting.

1. Set the reported altimeter setting on the barometric scale.

2. Compare the indicated altitude to the elevation of a known checkpoint. The maximum allowable error is 75 feet. If the difference exceeds 75 feet, the altimeter is out of tolerance for flight.

Procedure Two. Use this procedure if at a known elevation but a current altimeter setting is not available prior to engaging rotors.

1. Before engaging the rotor, set the altimeter to the known elevation and note the barometric setting.

2. After the rotor is turning, obtain and set the current altimeter

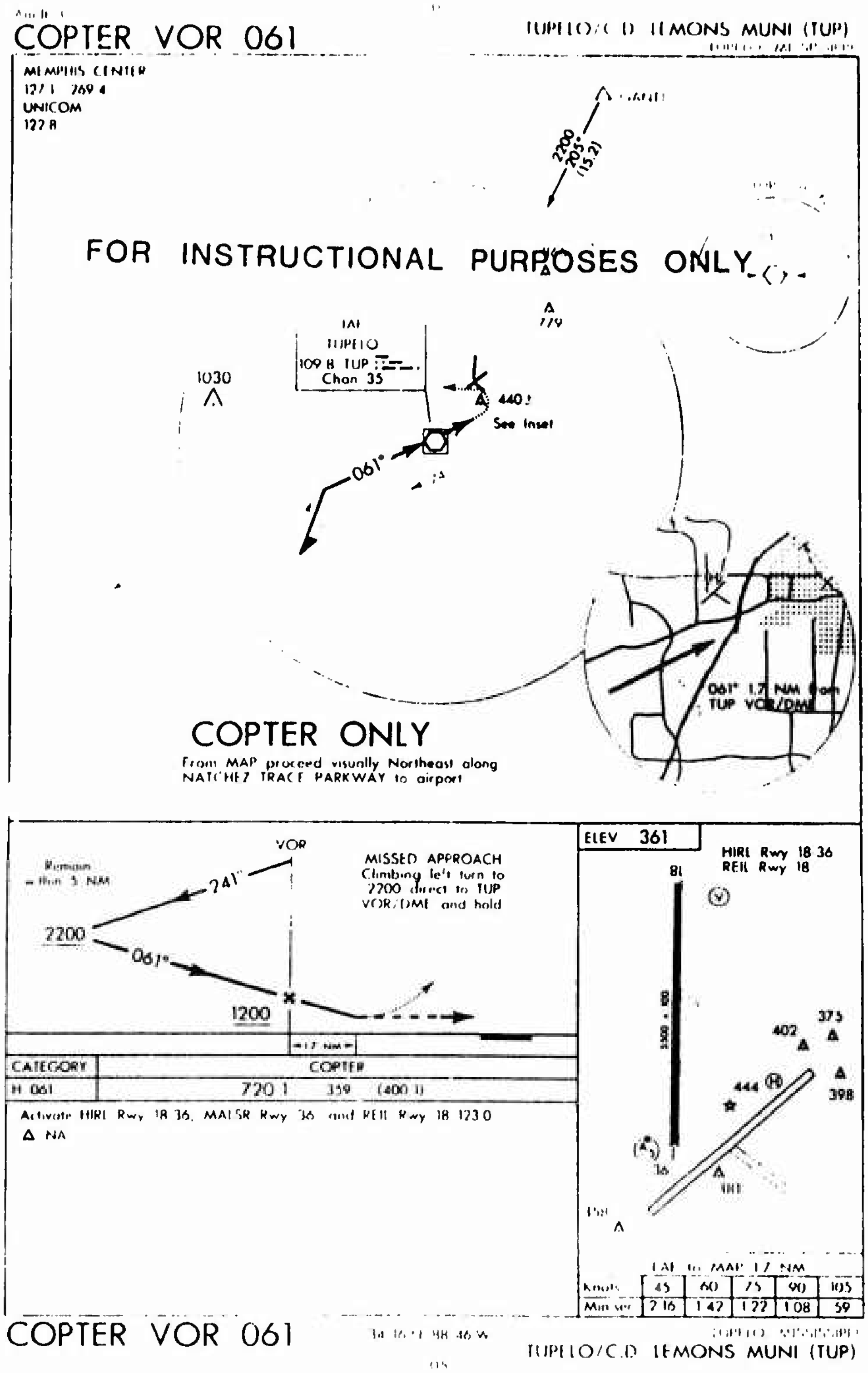
COPTER VOR 061
TUPELO/C.D. LEMONS MUNI (TUP)
MEMPHIS CENTER
UNICOM
122.8
FOR INSTRUCTIONAL PURPOSES ONLY
IAF
TUPELO
109.8 TUP
Chan 35
1030
440
See Inset
061°
779
061° 1.7 NM from TUP VOR/DME
COPTER ONLY
From MAP proceed visually Northeast along NATCHEZ TRACE PARKWAY to airport
VOR
241°
2200
061°
1200
MISSED APPROACH
Climbing left turn to 2200 direct to TUP VOR/DME and hold
CATEGORY
COPTER
H 061
720 1
359
(400 1)
Activate HIRL Rwy 18-36, MALSR Rwy 36 and REIL Rwy 18 123.0
ELEV 361
HIRL Rwy 18-36
REIL Rwy 18
402
375
444
398
36
Knots
45
60
75
90
105
2:16
1:42
1:22
1:08
59
COPTER VOR 061
TUPELO/C.D. LEMONS MUNI (TUP)

Figure 5-3

setting on the instrument.

3. Compare the current field barometric pressure set in the altimeter with altimeter setting noted before rotor engagement. If the difference exceeds ±75 feet, the instrument is out of tolerance.

Procedure Three. Use this procedure if engaging the rotor at an unknown elevation.

1. Taxi to a checkpoint of known elevation and set the current altimeter setting on the instrument.

2. Compare the indicated altitude to the elevation of a known checkpoint. The maximum allowable error is 75 feet.
NOTE: Rotor downwash will cause the altimeter to decrease after the rotors are engaged. This is a temporary error, so do not reset the altimeter to compensate for this decrease. (3:1-9)

TAXI OPERATIONS

As mentioned in the previous chapter, helicopter rotor downwash generates a significant amount of air velocity. This airflow can be hazardous during ground operations or when moving from point to point on an airfield. Particularly with large, heavy helicopters, rotor downwash can be dangerous when maneuverin areas of debris, people and even vehicles. Consequently, Air Traffic Control (ATC) procedures have been modified to accomodate helicopter movements.

Taxi.

ATC ground controllers will use the phrase "taxi" when helicopters will taxi on the airport surface via prescribed taxiways. (This procedure obviously applies only to helicopters with wheel-type landing gear). This is the preferred procedure when rotor downwash must be minimized. (16:C4-S3-9)

Hover Taxi.

Pilots may request and be issued instructions to "hover taxi" when moving short distances at slow forward speeds. Hover operations will be conducted at 25 feet or below. Pilots must avoid this procedure if rotor downwash is likely to cause damage to parked aircraft, or if blowing dust or snow could obscure visibility. (16:C4-S3-9)

Air Taxi.

This is the preferred method of helicopter ground operations at airports, provided conditions permit. The procedure expedites movement between points on the airfield and minimizes rotor downwash. Unless otherwise instructed, pilots using this option should remain below 100 feet above the ground. (16:C4-S3-9)

TAKEOFF AND INFLIGHT PROCEDURES

At this point in the mission profile, the next step would be to discuss takeoff procedures. However, due to the special considerations of the helicopter ITO, it has already been discussed in Chapter Four. Additionally, there are no unique differences in departure or enroute procedures applicable to helicopter flight. Pilots should consult AFM 51-37, the Airman's Information Manual (AIM) and the aircraft flight manual for general and specific requirements.

HOLDING PROCEDURES

As of this writing, there are no separate holding procedures designed specifically for helicopter use. However, there may soon be some changes as a result of a recent study conducted in conjunction with the latest Federal Aviation Administration (FAA) National Airspace Review (NAR). To quote the Helicopter Operations Task Group findings:

> The present minimum holding pattern size for helicopters is outlined in TERPS, Chapter 11, and accommodates aircraft operating at or below 175 knots...size of the holding pattern is 11 miles, and is also applicable to Category A fixed wing aircraft...Since helicopters do not hold (nor do most even cruise) at 175 knots, it is unlikely that helicopters would require this amount of airspace...The task group recommends that holding airspeeds of 60, 90 and 120 knots be established for helicopter operations...This would reduce holding pattern size, move holding airspace closer to the airport, and make it easier for ATC controllers to clear a helicopter approach on a non-interference basis in areas of a heavy mix of traffic. (17-9)

If these procedures are adopted, they should cause no substantial change in basic holding procedures. The primary effect will be to expedite the flow of helicopter traffic, and as such, will afford pilots a little less time to perform maneuvers.

WEATHER REQUIREMENTS

Before beginning an IAP, pilots are required to check the weather at the destination airfield to ensure conditions are adequate to safely complete the maneuver. Once again, helicopters are authorized to use somewhat less restrictive minimums when planning an approach.

Using A Fixed Wing IAP.

Helicopter pilots planning to fly a fixed wing instrument approach procedure may use one-half the published visibility minimums for the category being flown, but in no case may it be reduced to less than 1200 runway visual range

(RVR) or one-quarter mile. (6:8-3) Exception: When RVR is reported as a "less than" value, one-half the prevailing visibility (PV) is used to determine visibility requirements. (6:6-7)

Using A 'Copter-only IAP.

When planning to use a 'copter-only IAP, minimums listed on the procedure must be used as published, without any reduction. (6:8-1; 9:6-7)

APPROACH PROCEDURES

The various unique features of helicopter approach design have already been discussed. Pilots should carefully review planned IAPs, being particularly aware of unusual requirements of 'copter-only approaches (short course lengths, high descent rates, landing areas versus runways, missed approach climb gradients, etc.) Also, carefully review all notes on the IAP for nonstandard IAP criteria or special emphasis in information essential to safely complete the approach. (3:3-4)

LANDING PHASE

As in fixed wing operations, the helicopter landing phase begins upon leaving IMC and transitioning to outside visual references. There are certainly common potential hazards in such a maneuver regardless of the type of aircraft flown (temptation to "duck under" for landing, subsequent loss of visual references, etc.). Additionally, helicopter operations can compound these problems in several ways.

Less Restrictive Weather Requirements.

As pointed out, helicopter operations can be conducted under less restrictive ceiling and visibility conditions. While in most cases, this increases the chances of breaking out of the weather, it also results in placing the aircraft closer to the ground in a critical phase of flight.

High Descent Rates.

In addition to being closer to the ground at the end of a 'copter-only approach, high descent rates often associated with this type approach can cause additional hazards. In the example depicted in Figure 5-2 (16:340) we saw that in a no-wind condition, arriving at the MAP at minimum descent altitude required a final approach descent rate in excess of 600 feet per minute. Should the pilot elect to arrive at the MDA one-half mile early, in order to have more time available for runway search, he or she would have to increase the descent to over 750 feet per minute. Add a ten knot tailwind to the equation and the rate further increases to almost 900 feet per minute. If the ceiling is at the minimum required, the aircraft could be as low as 258 feet above the landing area, significantly reducing reaction time needed to acquire the runway and transition to landing.

Rotor Downwash.

As pointed out several times, helicopter rotor wash can cause significant visibility problems. While this should result in few problems when flying to an airport runway, use caution when transitioning to land from an approach to an unfamiliar landing area or helipad. Even with careful pre-planning, there is always the potential of encountering unexpected debris, snow or dirt which could hamper visibility is disturbed by downwash.

CONCLUSION

This chapter ties previous information on helicopter characteristics, approach design criteria and helicopter instrument maneuvers to a framework of a helicopter mission profile. The aircraft's slow speed and maneuverability enable pilots to apply less restrictive weather requirements when planning flights under instrument flight rules. 'Copter-only instrument approach procedures have been designed to further take advantage of such unique abilities, but also contain some procedures which should be fully understood to preclude hazardous situations from developing. Finally, considerations surrounding the landing phase were discussed to ensure safe completion of the mission to final touchdown. Careful review of these procedures and techniques will increase understanding of both the unique features of helicopter instrument flight and their potential pitfalls.

Chapter Six

CONCLUSION

Helicopter flying offers pilots some special opportunities unavailable to those in the fixed wing aircraft community. The helicopter's slow speed and inherent maneuverability, coupled with fixed wing comparable instrumentation, enables it to operate to and from austere locations under the most minimal weather conditions. But there are trade-offs to consider. Helicopter pilots must adjust their concept of instrument flying to accommodate the aircraft's operating characteristics. And, too, they must be aware that a helicopter's special capabilities also give rise to a unique set of hazards, especially when operating in conditions using those special capabilities to the utmost.

Those who design our airspace have recognized the helicopter's unique features and have incorporated them into their present and future plans. Efforts continue to adjust airspace design to make even better use of helicopter characteristics. Again, however, pilots must become thoroughly familiar with those changes in order to take full advantage of the aircraft's capability, in the safest possible manner.

Helicopter instrument flying is different from fixed wing flying. It is challenging and demanding in its own right. A thorough understanding of the differences, as well as the proper techniques and procedures, can make helicopter instrument flying a rewarding experience. Helicopter pilots may be "introspective anticipators of trouble." But they also know that "to fly is heavenly--to hover, divine."

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INDEX

Air Taxi, 23
Alternate requirements, 17-18
Altimeter setting procedures, 21,23
Circling approach, 10
Climbs, 14
Control and performance concept,5,11-12
Copter-only approach, 25
Copter straight-in approach, 10
Decelerative approach, 10
Descent gradients, 8,18,25
Descents, 14
Destination weather requirements, 17
Final approach, 9
Flight control applications, 5
Forward airspeed, 6
Height above landing, 7
Height above surface, 8
Helicopter-only criteria, 7
Holding procedures, 24
Hover taxi, 23
ILS approach, 9
Instrument approach review, 18,21
Instrument cockpit check, 21,23
Instrument takeoff, 12-13
IPIS, 2
Landing, 25
Landing area, 8
Length of approach,8,18
Low speed approaches, 18
Missed approach, 9,21
National airspace review, 24
NDB approach, 9
Non-precision approach, 9
Pitch control, 5
Pitot-static system, 6
Point-in-space approach, 8,21
Power control, 5
Precision approach, 9
Preflight planning, 17-21
Rotor downwash, 5-6,12-13,26
Straight and level flight, 13
TACAN approach, 9
Takeoff minimums, 18
Taxi operations, 23
Turning performance, 6,13-14
Turns, 13
Unusual attitude recoveries, 14-15
Visibilities, 6,9,17-18
VOR approach, 9
Weather requirements, 17-18,24-25